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The Level of Physical Development and Physical Fitness in 6–7-Year-Old Children from School and Pre-School Institutions in Gdansk

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Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Key words: *physical development, physical fitness, children, school, pre-school*

Abstract

Background: *Interest in the development of a 6-7-year-old child derives among other things from the necessity to evaluate child's readiness to take up a regular educational process. Physical development and physical fitness of the child are components of school maturity.*

The purpose of the study was to show similarities and differences in the level of physical development and fitness of children attending school and pre-school institutions in the years 2005-2009 in Gdansk.

Material/Methods: *15,578 children (8,006 boys and 7,572 girls) from Gdansk were subject to research in the years 2005-2009. The measurements of the height, body mass and 5 skin folds were carried out. BMI and %BF were calculated. To determine the physical fitness level, the following tests were applied: sit and reach, standing broad jump, sit-ups and a 3-min step-test.*

Results: *In pre-schools children higher values of body height were observed in the investigated period (2005-2009) but, at the same time, there were no differences in body mass between children from pre-schools and schools. Nor did the children differ in the amount of fat deposition. In the fitness level the biggest differences between the results achieved by children from schools and pre-schools were noted in the test of standing broad jump on both feet. Both boys and girls from pre-schools got higher scores in this test and their post-effort HR was lower in comparison with their peers from schools.*

Conclusions: *Differences in the level of physical fitness, especially its manifestations depending on everyday physical activity, reflect well on conditions created for children in pre-schools.*

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Introduction

Interest in the development of a 6-7-year-old child derives, among other things, from the necessity to evaluate child's readiness to take up a regular educational process.

So far, if a six-year-old has fulfilled norms of school maturity, the parents could make a decision to send their child to school earlier. If the child did not begin his/her education in the first grade of primary school, participation in the "0 class" organized at school or pre-school institutions has been obligatory since 2004. From 2014 all six-year-olds will have to start their primary education at school.

School maturity is a notion which covers physical, psychological and social aspects of a child's development. According to S. Szuman [1], "school maturity is the state in which the level of physical, social and psychological development makes a child sensitive and susceptible to systematic education and teaching."

The assessment of school maturity is an interdisciplinary issue. Appropriate physical development, which undoubtedly is a primary condition to achieve such maturity, proceeds differently in boys and girls. It is a process within the child's body, which consists in achieving quantitative (growth) and quality features (diversification) and improving the structure and function of particular organs and systems (maturity) [2]. A part of physical development is a somatic development, most often described through the height and body weight.

Development of physical fitness and capacity is a function of physical development [3]. It is also an indisputable positive measure of health [4, 5, 6] and school maturity [7, 8].

School readiness is achieved by a child under concrete financial and social conditions. It is made of various, gained in a particular child's environment, experiences in the motor, intellectual, emotional and social spheres [9]. In the present study we took one of the factors of the environment into consideration: the place of participating in education – the school or pre-school. In 2006 a report from nationwide research on 6-year-olds was published [10]. Authors of this research observed a higher level of motor abilities in children attending schools. However, they did not claim differences in motor development which would dependent on the kind of educational institution (school or pre-school). As it was a one-time study, it is worth validating this problem based on longer observations.

The purpose of the study was to show similarities and differences in the level of physical development and fitness of children attending school and pre-school institutions in the years 2005-2009 in Gdansk. Since, irrespective of where this process takes place, the same curriculum is required and similar stimuli should affect the child, thus the occurrence of significant differences in the level of physical development and fitness in the subjects is not assumed.

Material and Methods

15,578 children (8,006 boys and 7,572 girls) from Gdansk were subject to research in the years 2005-2009. Table 1. presents the number of groups in particular years.

Tab. 1. Number of examined boys and girls in particular years

Year	Boys (n)	Girls (n)	Total (n)
2005	1,702	1,684	3,386
2006	1,686	1,498	3,184
2007	1,457	1,454	2,911
2008	1,705	1,530	3,235
2009	1,456	1,406	2,862
Total	8,006	7,572	15,578

The arithmetic mean of the subjects' age was 6.6 (0.4) years. Children participated in the research after previous approval of the pediatrician. Body height and weight measurements followed the requirements [11]. BMI was calculated according to the formula: body weight (kg)/body height² (m²).

Skin-folds measurements were conducted on: above biceps brachii and triceps brachii, below the spatula, above the iliac spine and on the internal side of the calf. These measurements had to satisfy the requirements and were carried out by a Lange caliper, on the left side of the body [12]. The percentage of the fatty tissue was calculated (%BF) according to the formula [13]:

$$\% \text{ BF} = \left[\frac{4.95}{G} - 4.5 \right] \times 100\%$$

Body density (G) was calculated according to the following formulas [14]:

- for boys $1.1533 - 0.0643 \times \log \sum 4 \text{ folds}^1$

- for girls $1.1369 - 0.0598 \times \log \sum 4 \text{ folds}$

In the presence of parents and with their approval, motor tests and a step-test were carried out. To determine the fitness level the following tests were performed: sit and reach, standing broad jump, and sit-ups. To evaluate physical capacity, included here in physical fitness, a 3-minute step test (height of the step = 30.5 cm, pace – 24 up/down steps per min) was applied. Post-effort average HR determined the capacity index [15, 16]. This frequency was registered for a minute in a sit, few seconds after the effort at the latest, with the use of sport-tester PE 3000.

Results

The results were put in tables considering the gender, kind of educational institution (pre-school/school) and the year of the research. In tables 2-5 somatic developmental data of children are presented.

Tab. 2. Numerical description of body mass in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	S	
23.8	4.5	23.4	4.0	24.1	4.7	0.0027	2005	23.3	4.5	23.3	4.1	23.3	4.7	0.9612
23.9	4.7	23.8	4.5	23.9	4.7	0.6508	2006	23.1	4.3	23.1	4.1	23.2	4.3	0.5997
24.2	4.6	24.3	4.4	24.1	4.7	0.4340	2007	23.4	4.3	23.3	3.9	23.5	4.5	0.6549
23.9	4.6	24.0	4.5	23.8	4.6	0.3820	2008	23.2	4.3	23.2	4.1	23.2	4.4	0.8936
23.9	4.5	23.9	4.5	23.9	4.6	1.0000	2009	23.2	4.4	23.3	4.4	23.1	4.4	0.3810
23.9	4.6	23.9	4.4	24.0	4.7	0.3905	total 2005-2009	23.3	4.4	23.3	4.1	23.2	4.5	0.9741

Tab. 3. Numerical description of body height in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	S	
121.1	5.6	120.9	5.3	121.1	5.8	0.4732	2005	120.3	5.7	120.7	5.6	120.1	5.7	0.0365
122.0	5.4	122.1	5.4	122.0	5.5	0.7057	2006	121.2	5.7	121.2	5.7	121.2	5.7	0.8877
122.5	5.4	122.9	5.7	122.3	5.3	0.0665	2007	121.5	5.4	121.4	5.2	121.5	5.5	0.8955
122.5	5.7	122.8	5.5	122.3	5.7	0.1563	2008	121.3	5.6	121.6	5.6	121.1	5.6	0.1045
122.3	5.5	122.7	5.6	122.1	5.4	0.0430	2009	121.2	5.6	121.4	5.6	121.1	5.5	0.2302
122.1	5.6	122.3	5.5	121.9	5.6	0.0152	total 2005-2009	121.0	5.6	121.3	5.6	120.9	5.6	0.0246

¹ Folds above biceps brachii, triceps brachii, below scapula and above the iliac spine

Tab. 4. Numerical description of the body mass index in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	S	
16.2	2.2	15.9	2.0	16.3	2.2	0.0003	2005	16.0	2.1	15.9	2.0	16.1	2.2	0.2241
16.0	2.2	15.9	2.1	16.0	2.3	0.3886	2006	15.7	2.0	15.6	1.8	15.7	2.0	0.4270
16.0	2.1	16.0	2.0	16.0	2.2	0.9087	2007	15.8	2.1	15.8	2.0	15.8	2.2	0.8414
15.8	2.0	15.8	2.0	15.8	2.1	0.6378	2008	15.7	2.0	15.6	1.8	15.7	2.1	0.2973
15.9	2.1	15.8	2.0	15.9	2.2	0.1934	2009	15.7	2.0	15.7	2.0	15.7	2.1	0.7568
16.0	2.1	15.9	2.0	16.0	2.2	0.0030	total 2005-2009	15.8	2.1	15.7	1.9	15.8	2.1	0.1985

Tab. 5. Numerical description of fat percentage in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	S	
16.2	6.9	15.7	6.1	16.4	7.2	0.0360	2005	19.4	5.9	19.2	5.5	19.5	6.1	0.3658
15.5	7.9	15.5	7.8	15.5	8.0	0.9487	2006	18.4	5.9	18.4	6.1	18.4	5.8	0.9688
16.2	8.4	16.2	7.9	16.1	8.6	0.8529	2007	18.8	6.2	18.8	5.8	18.8	6.3	0.9997
15.3	7.0	15.2	6.7	15.3	7.2	0.7755	2008	18.5	5.5	18.1	5.0	18.7	5.8	0.0647
14.8	6.1	14.5	6.1	15.0	6.1	0.1608	2009	18.1	5.3	18.3	5.3	18.0	5.4	0.4278
15.6	7.3	15.4	6.9	15.7	7.5	0.1165	total 2005-2009	18.7	5.8	18.6	5.6	18.7	5.9	0.3884

No statistically significant differences in the level of body mass between children from pre-schools and schools in the years 2005-2009 were noted. When calculations were made for each year separately, the differences were revealed in boys in 2005 exclusively. This year boys attending school were characterized by significantly higher body mass. Children from schools were taller than peers from pre-schools when calculations were made for all years altogether. When calculations were made for each year separately, the differences were revealed in boys in 2009 and in girls in 2005. Significant differences in body mass indices were noted in boys exclusively. Higher values appeared in boys from "0 school classes" in 2005 and in calculations considering all years altogether.

Fat deposition reflected by %BF was significantly higher in boys from schools also in 2005 exclusively. In girls substantial differences in values of fat percentage were not noted.

Tab. 6. Numerical description of the results of sit and reach in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	s	
19.7	5.6	19.6	5.5	19.7	5.7	0.6845	2005	21.7	5.3	21.7	5.4	21.7	5.2	0.8845
20.7	5.2	20.6	4.7	20.8	5.4	0.5720	2006	23.0	4.6	23.2	4.5	22.9	4.7	0.2615
21.5	5.1	21.4	4.9	21.6	5.3	0.4577	2007	23.8	4.7	23.9	4.6	23.8	4.8	0.5967
20.6	5.6	20.4	5.4	20.7	5.8	0.4069	2008	23.2	5.0	23.1	4.8	23.3	5.1	0.5258
19.5	6.1	19.7	6.0	19.4	6.1	0.4393	2009	22.8	5.5	23.0	5.5	22.7	5.6	0.2583
20.5	5.6	20.3	5.4	20.4	5.7	0.3998	Total 2005-2009	22.9	5.1	22.9	5.0	22.8	5.1	0.4012

Tab. 7. Numerical description of the results of standing broad jump in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	s	
105.6	16.7	105.6	16.5	105.7	16.8	0.9097	2005	100.7	16.1	101.8	15.3	100.2	16.5	0.0619
108.4	15.6	108.6	14.6	108.3	16.0	0.7538	2006	103.5	14.4	105.7	13.5	102.5	14.7	0.0000
108.5	14.8	108.1	15.1	108.7	14.6	0.4588	2007	103.5	14.3	104.5	13.7	103.0	14.6	0.0646
111.1	19.1	113.2	18.9	109.8	19.0	0.0007	2008	107.5	16.7	110.7	16.3	105.8	16.6	0.0000
109.5	16.3	110.7	15.4	108.8	16.9	0.0431	2009	107.4	15.0	109.3	13.8	106.5	15.5	0.0010
108.6	16.7	109.3	16.5	108.2	16.8	0.0070	total 2005-2009	104.4	15.6	106.3	15.0	103.5	15.8	0.0000

Tab. 8. Numerical description of the results of sit-ups in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	s	
12.7	5.3	12.9	5.0	12.7	5.4	0.5577	2005	13.2	4.8	13.2	4.9	13.2	4.8	0.8240
14.1	4.9	13.6	5.3	14.3	4.8	0.0196	2006	13.9	4.6	13.9	4.4	13.9	4.6	0.8563
14.6	4.5	14.7	4.5	14.6	4.5	0.6936	2007	14.2	4.2	14.5	4.0	14.0	4.3	0.0234
13.4	5.2	14.0	5.2	13.0	5.1	0.0001	2008	13.2	4.8	13.9	4.7	12.9	4.8	0.0001
13.3	5.1	13.3	5.4	13.3	5.0	0.9845	2009	13.8	4.7	13.7	5.1	13.8	4.5	0.6040
13.6	5.1	13.7	5.1	13.6	5.0	0.2437	total 2005-2009	13.6	4.6	13.8	4.7	13.5	4.6	0.0168

Tab. 9. Numerical description of post-effort HR in boys and girls

Boys							Year	Girls						
total		pre-school		school		P*		total		pre-school		school		P*
\bar{x}	s	\bar{x}	s	\bar{x}	s			\bar{x}	s	\bar{x}	s	\bar{x}	s	
113.1	14.0	112.2	13.6	113.7	14.3	0.0693	2005	121.9	16.1	120.8	15.4	122.6	16.5	0.0485
112.5	13.7	111.2	12.8	113.2	14.1	0.0121	2006	119.0	14.6	117.9	13.2	119.6	15.1	0.0613
110.9	15.0	109.5	13.6	111.8	15.7	0.0079	2007	117.6	15.1	116.1	13.7	118.4	15.8	0.0080
111.8	12.9	112.0	12.8	111.7	12.9	0.7191	2008	119.5	14.2	118.5	13.6	120.1	14.5	0.0607
111.9	12.8	110.9	12.5	112.6	13.0	0.0287	2009	119.5	14.3	120.4	15.0	119.0	13.9	0.0993
112.2	14.3	111.0	13.4	112.9	14.7	0.0000	total 2005-2009	119.6	15.4	118.3	14.3	120.2	15.9	0.0002

There were no statistically significant differences between children from pre-schools and schools in the results of sit and reach (Table 6).

In standing broad jump tests children from pre-schools achieved characteristically higher results in the observations carried out in all years altogether; and when studied separately, the results were higher in 2008 and 2009 in both boys and girls, and only in girls in 2006 (Table 7). Statistically significant differences were noted in sit-ups. Boys from schools achieved higher scores in 2006 and from pre-schools in 2008. Girls from pre-schools got higher scores in 2007 and 2008, and altogether in the years 2005-2009 in comparison with peers from schools (Table 8). In children from pre-schools lower values of arithmetic means in post-effort HR were observed in all years altogether and separately in 2006, 2007, 2009 in boys and 2005, 2007 in girls (Table 9).

Discussion

The purpose of the study was to compare the level of physical development and physical fitness in 6-year-old children learning at schools and pre-schools.

In children attending pre-schools in the years 2005-2009 higher values of body height were noted, and at the same time differences in body mass between children from pre-schools and schools were not found. Authors of nationwide research also revealed the tendency of achieving higher

developmental parameters in children from pre-schools [10]. Children did not differ in the amount of fat deposition (%BF) either. In the level of physical fitness the biggest differences between school and pre-school subjects were noted in standing broad jump tests. Both boys and girls from pre-schools got higher scores in the test. This test is used in many modern set tests nowadays (EUROFIT, the International Test) and for 6-year-olds it is a coordination challenge as well as a trial assessing the children's strength and speed abilities [17]. Such diversification of the results, which is more beneficial for children from pre-schools, can be partially explained by somatic conditions. These children were taller, but many authors, demonstrating the relationship between body height and results in long jump test, simultaneously emphasize the low level of these correlations amongst the youngest children [18]. Forward sit and reach, commonly exercised as the measure of functional suppleness, is a component of fitness test in the conception of health-related-fitness [19]. The result in this test depends on the mobility of joints of the spine as well as body proportions and a range of motion of hips. The level of suppleness was similar in children from school and pre-school institutions. From the point of view of health it is necessary to assess suppleness parallel to the assessment of stabilization possibilities of the spine [20]. Applied in the research sit up test assesses strength endurance of the torso muscles and the test itself is also included in the conception of health-related fitness.

The diversity depending on the kind of educational institution appeared in our examinations in girls exclusively. Girls from pre-school "0" classes achieved a higher level of strength endurance of stomach muscles than their peers from schools. In boys, statistically significant differences in the years 2005-2009 were not observed. Shaping both suppleness and strength endurance of stomach muscles requires intentional exercises and it is impossible to expect advantageous changes in these aspects of physical fitness only in connection with everyday physical activity. Adaptive abilities for aerobic effort were revealed by step-test results, and more precisely, a reaction of the cardiovascular system on this submaximal effort. A higher level of these possibilities was observed in boys and girls from pre-school "0" classes in the years 2005-2009, and separately in 2006, 2007, 2009 in boys. A more beneficial result (lower post-effort HR) was seen in girls from pre-schools in 2005 and 2007. Results of this test are undoubtedly connected with everyday, also voluntarily undertaken, physical activity of the child. Since physical activity for 6-year-olds is an effect of a natural desire to exercise, creating appropriate conditions for such activity is very important. The report from nationwide research reveals a distinct diversification in undertaking physical activity between school and pre-school children, to the benefit of the latter [10].

Conclusion

It seems that observed differences in the level of physical fitness, especially its signs which depend on everyday physical activity, weigh in favor of conditions created for children in pre-schools.

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